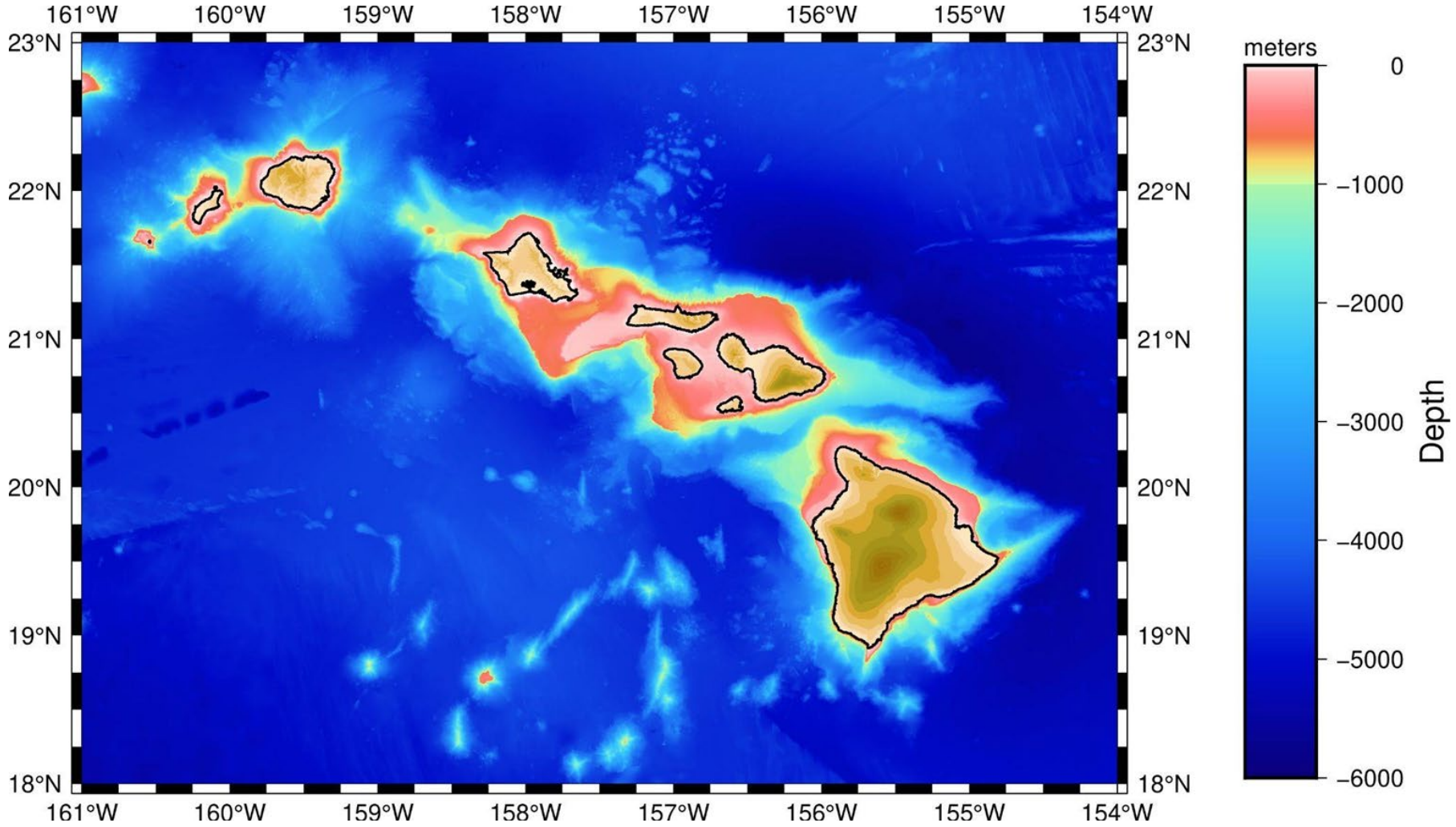
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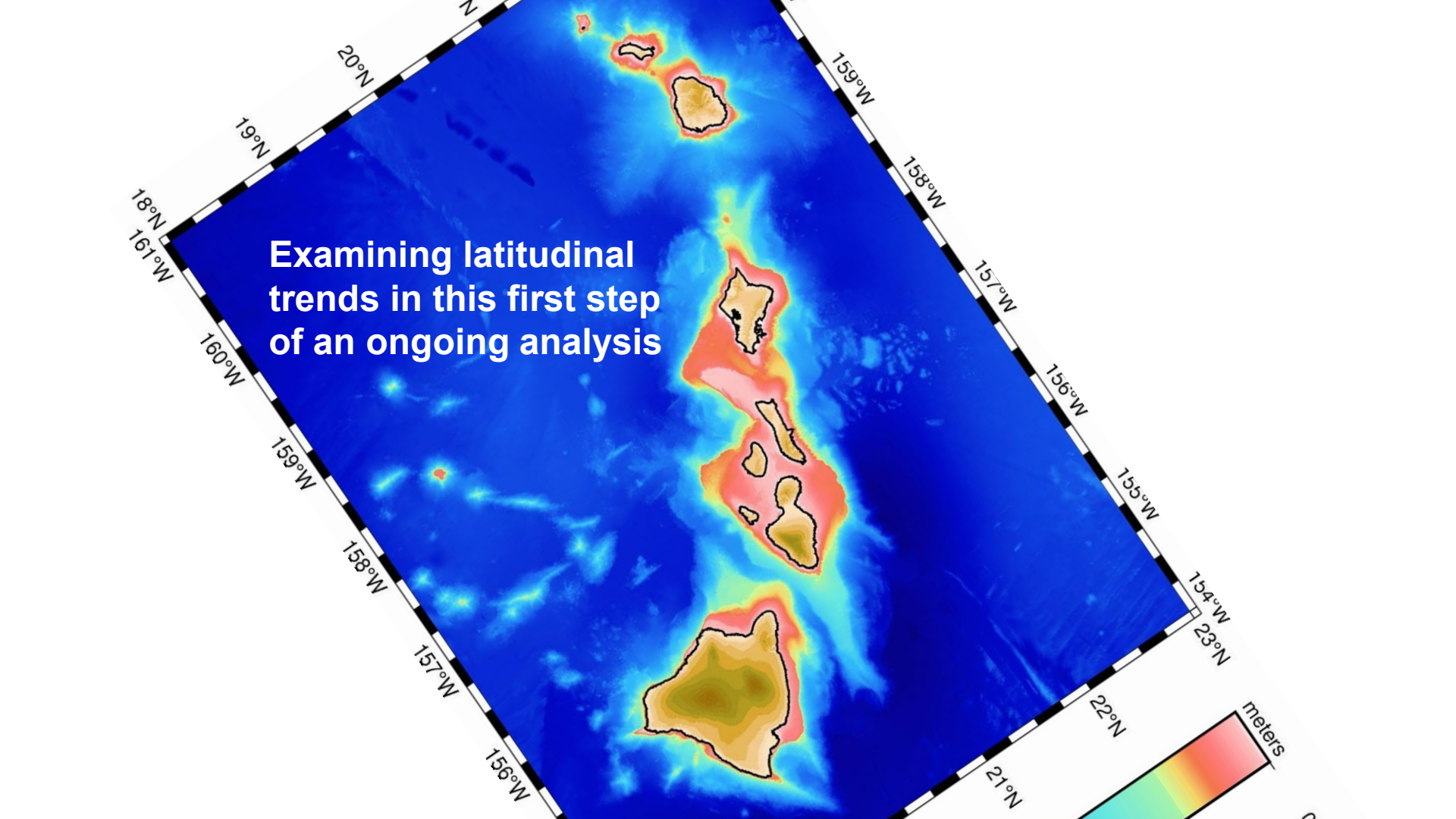
Distributional changes of marine species in Hawaii using 79 years of commercial ~~catch~~ data landings

Donald R. Kobayashi
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Honolulu, Hawaii
USA

(no AI or SI was used in this analysis or presentation)

20°N
19°N
18°N
161°W
160°W
159°W
158°W
157°W
156°W
159°W
158°W
157°W
156°W
155°W
154°W
23°N
22°N
21°N
meters


161°W
160°W
159°W
158°W
157°W
156°W
155°W
154°W
23°N
22°N
21°N
20°N
19°N
18°N
meters
0
−1000
−2000
−3000
−4000
−5000
−6000
Depth


Examining latitudinal trends in this first step of an ongoing analysis
20°N
19°N
18°N
161°W
160°W
159°W
158°W
157°W
156°W
159°W
158°W
157°W
156°W
155°W
154°W
23°N
22°N
21°N
meters

Presentation Outline

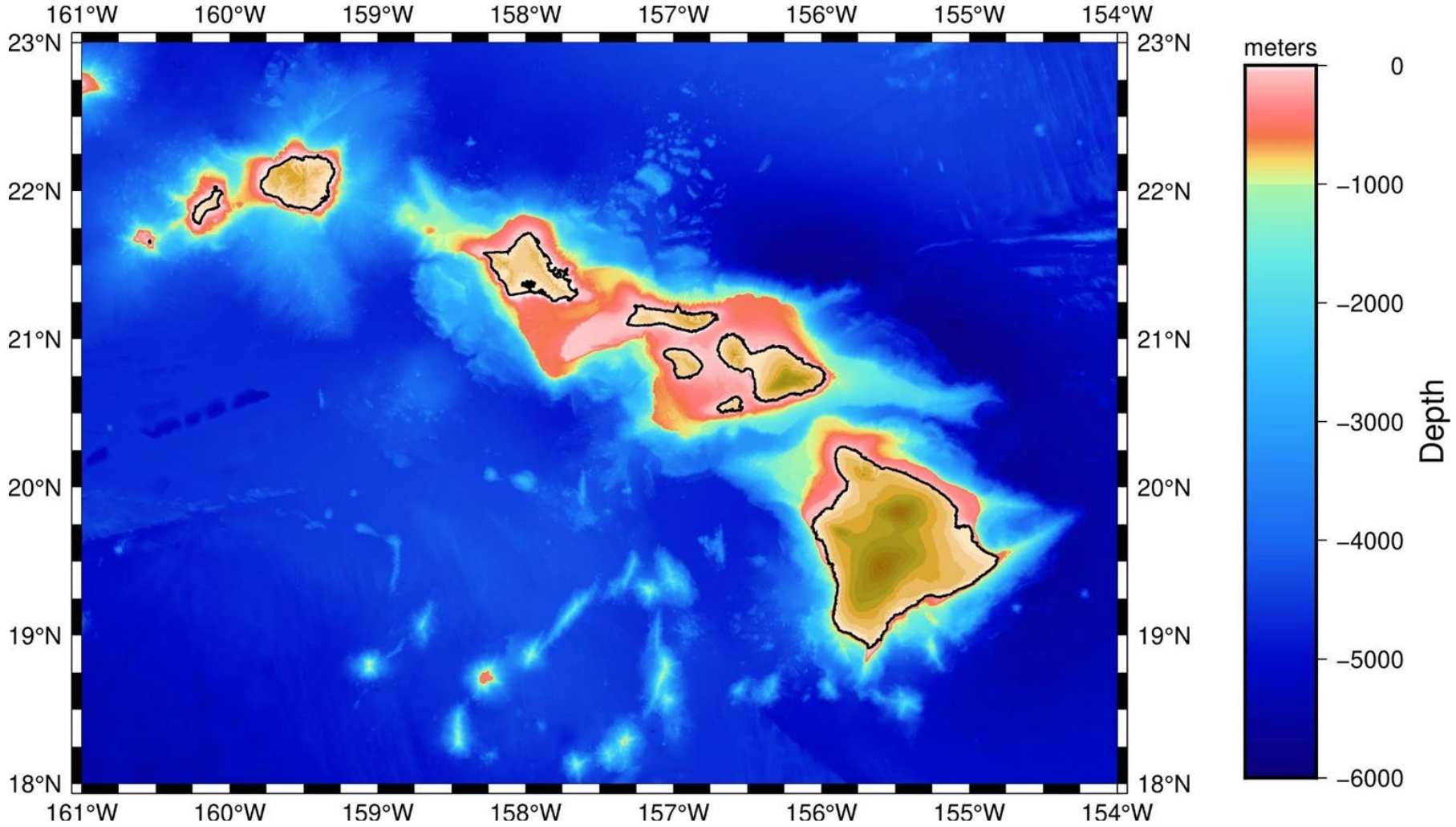
- Goal of Study
- Data Description & Methodology
- Trend Analysis
- Dynamic Factor Analysis
- Summary & Next Steps

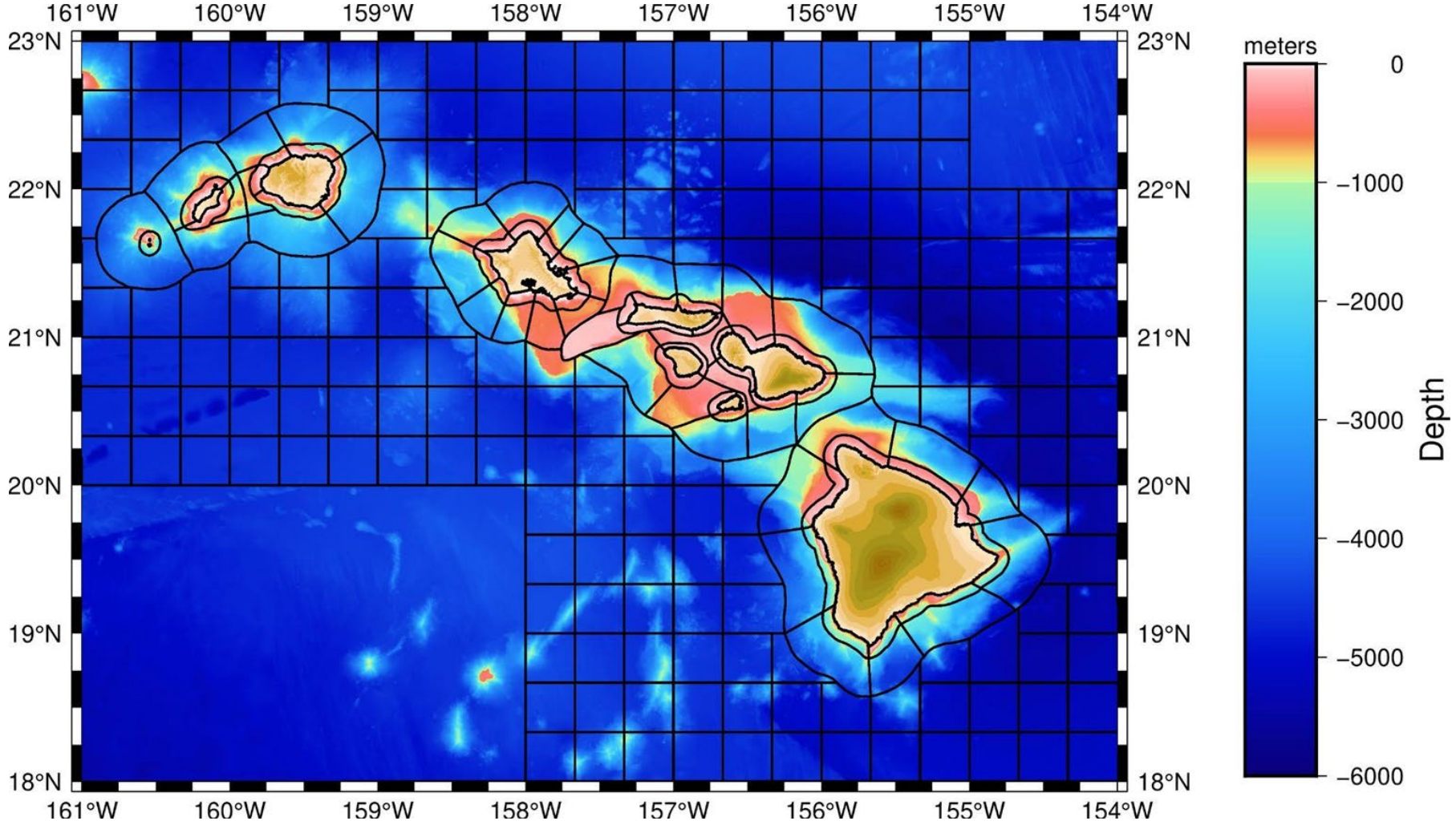
Goal of Study

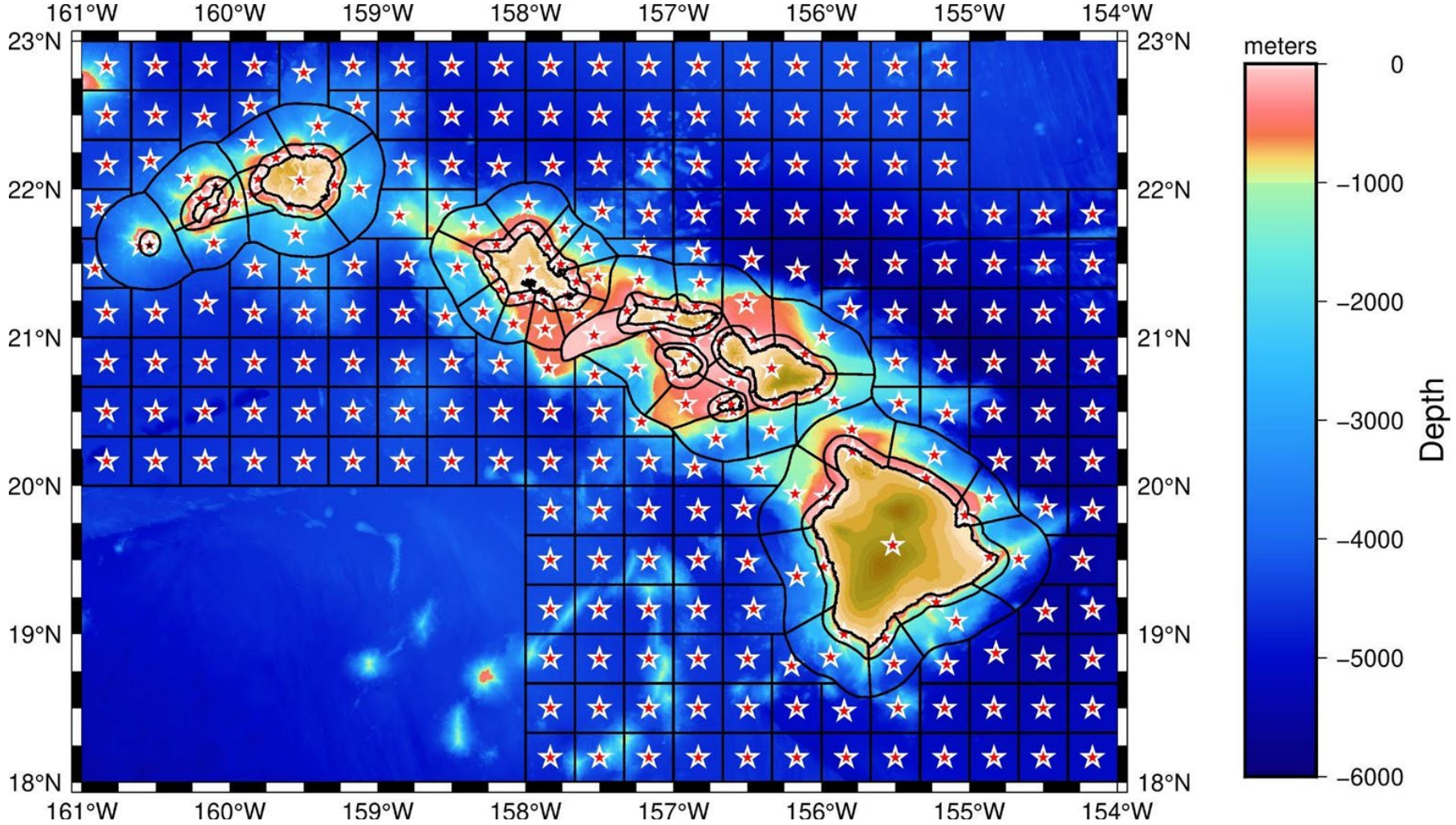
- **Utilize a long time series of fishery data to infer changes in species distributions over time**

Data Description & Methodology

- Commercial Marine Landings collected by State of Hawaii Division of Aquatic Resources, Department of Land and Natural Resources
- Originated as an economic dataset for Hawaii, largest and oldest fishery database in Hawaii
- 1948-2026 (n=79 years), ~240 taxa tabulated, many at species level
- Data cleaning steps with goal of daily landings for a CPUE-type measure as a proxy for abundance (pounds per day)
- Calculate annual average latitude of landings (e.g., center of mass of CPUE) using centroid of reporting area weighted by CPUE
- Trend analysis to look for northward, southward patterns over time
- Dynamic Factor Analysis to cluster time series into salient patterns

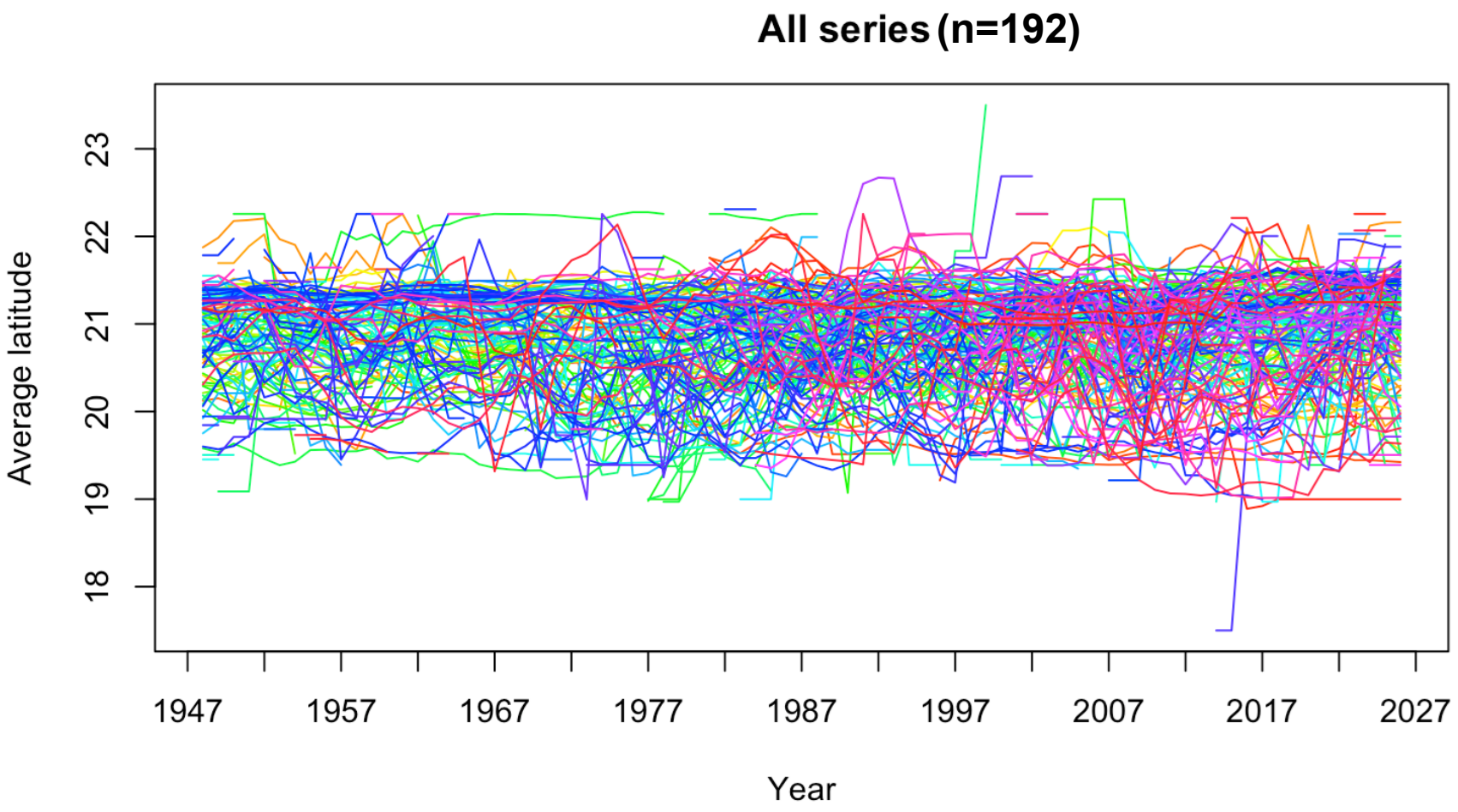

161°W
160°W
159°W
158°W
157°W
156°W
155°W
154°W
23°N
22°N
21°N
20°N
19°N
18°N
meters
0
−1000
−2000
−3000
−4000
−5000
−6000
Depth

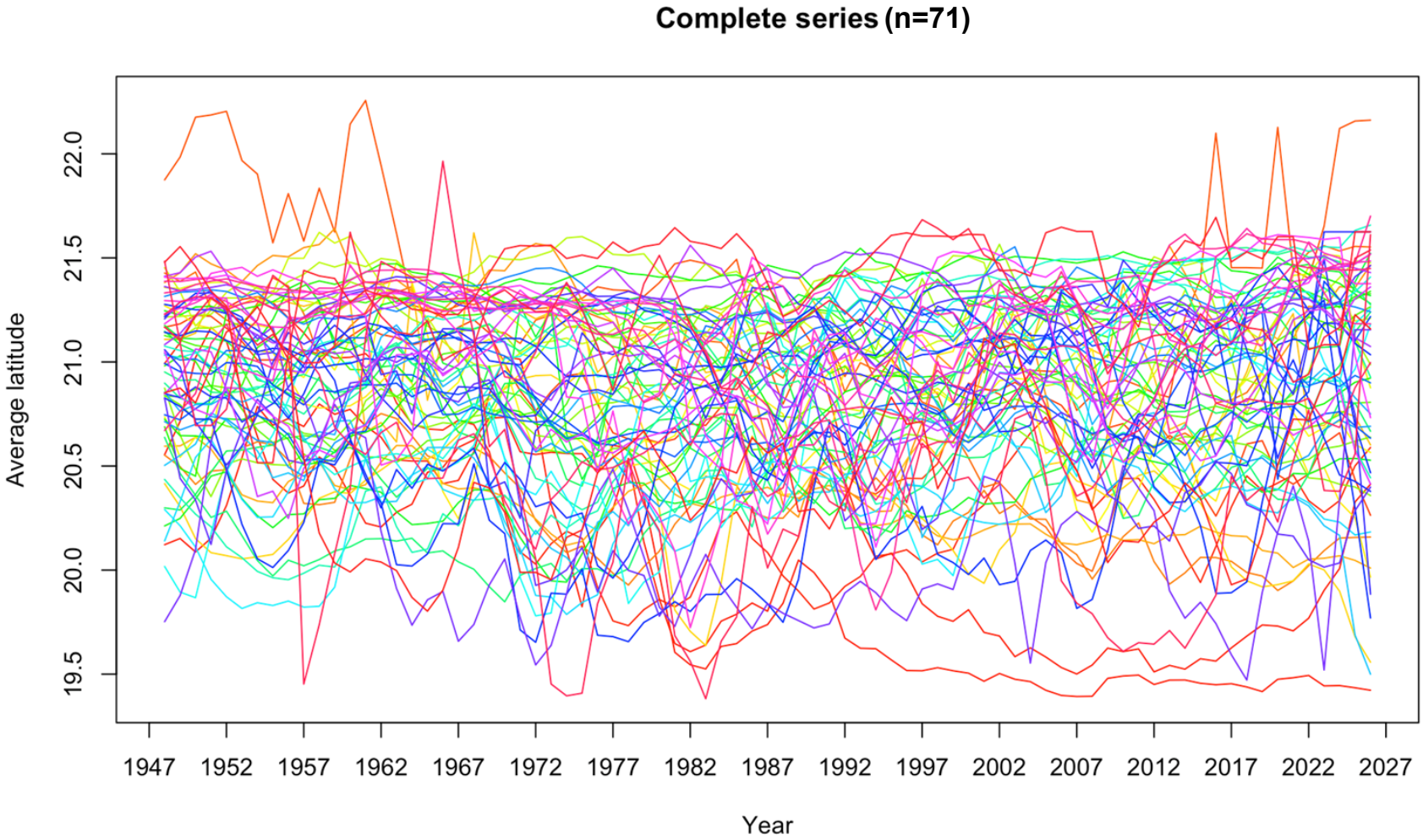

161°W
160°W
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meters
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−4000
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−6000
Depth

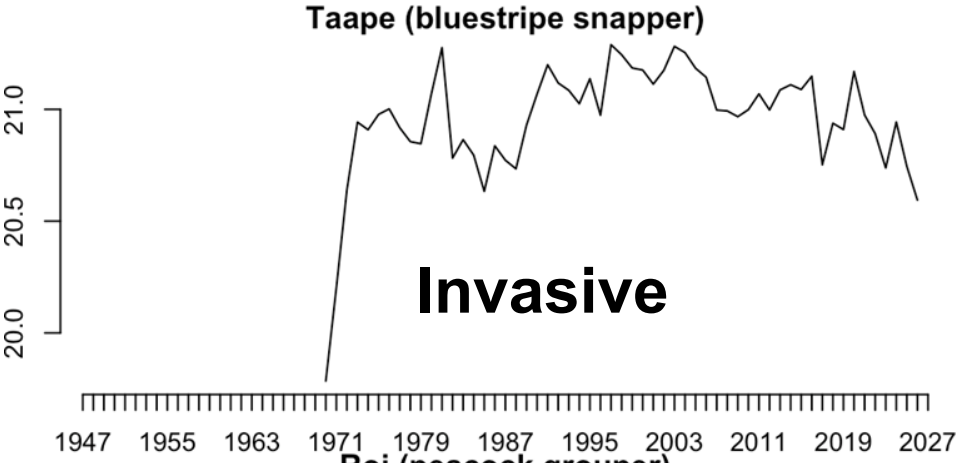

161°W
160°W
159°W
158°W
157°W
156°W
155°W
154°W
23°N
22°N
21°N
20°N
19°N
18°N
meters
0
−1000
−2000
−3000
−4000
−5000
−6000
Depth

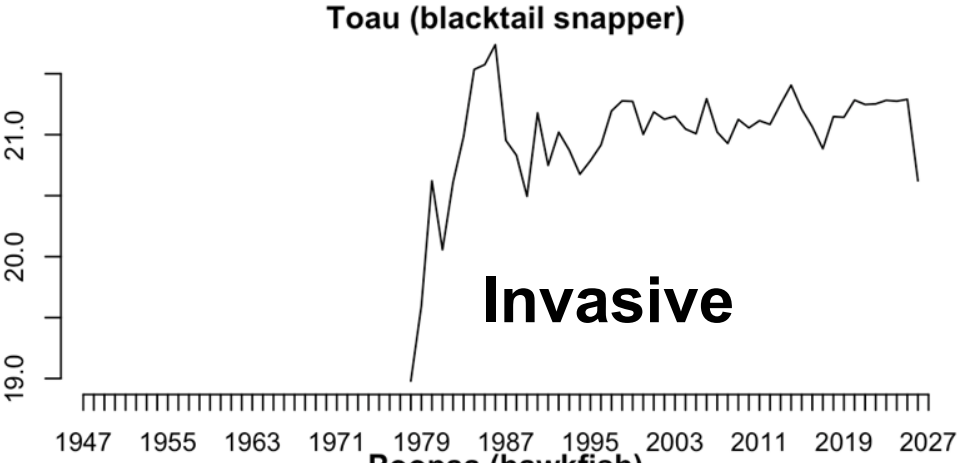
Trend Analysis

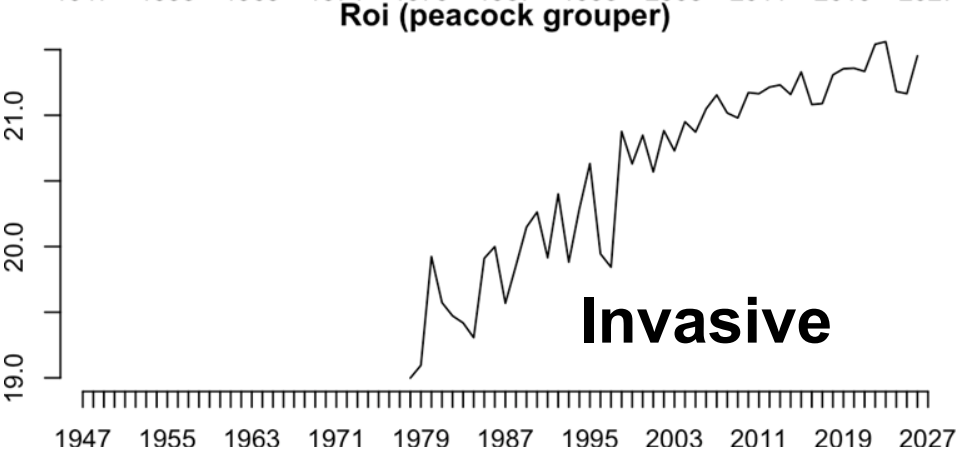
- Perform simple linear regressions of CPUE-weighted average latitude by year
- Examine slopes of fitted regressions for significant departures from zero
- Subset of trajectories with at least 40 years of data (n=132)

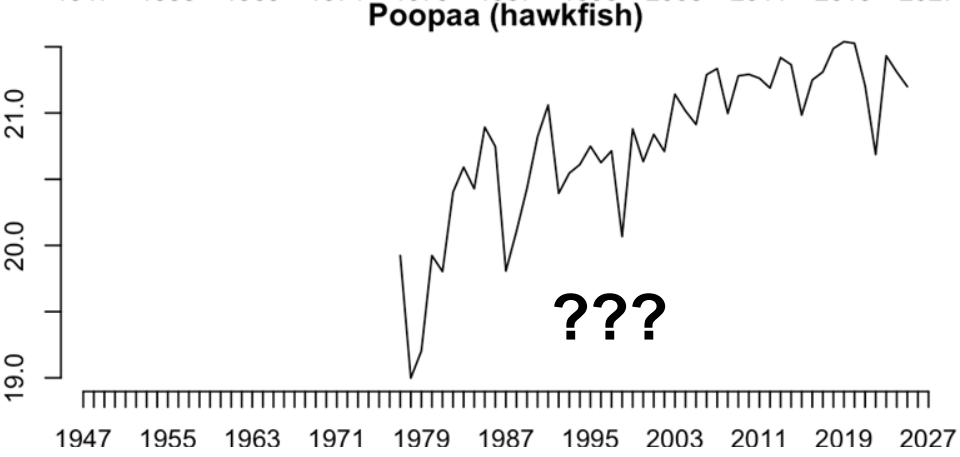

All series (n=192)
Average latitude
18
19
20
21
22
23
1947
1957
1967
1977
1987
1997
2007
2017
2027
Year


Complete series (n=71)
Average latitude
19.5
20.0
20.5
21.0
21.5
22.0
1947
1952
1957
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007
2012
2017
2022
2027
Year

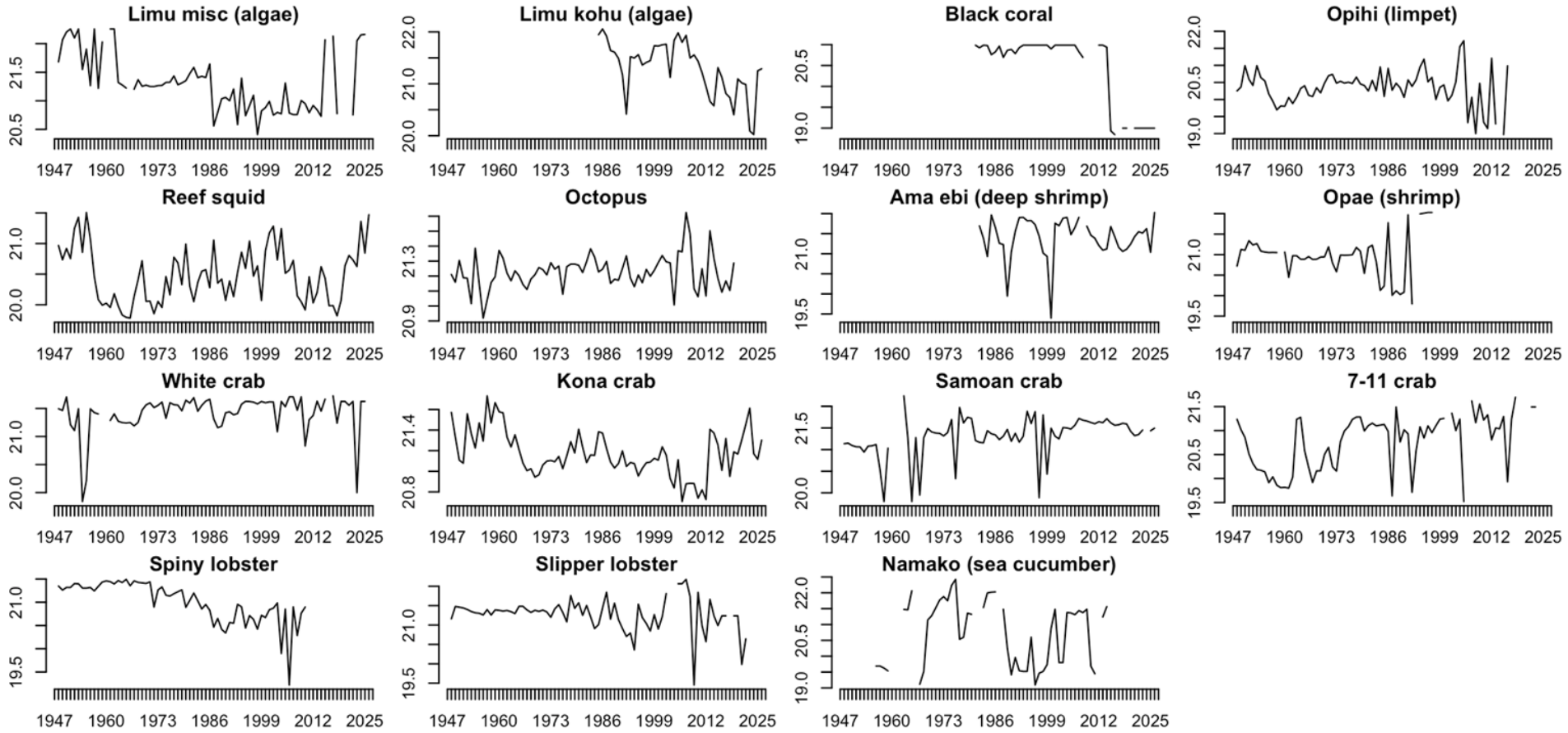




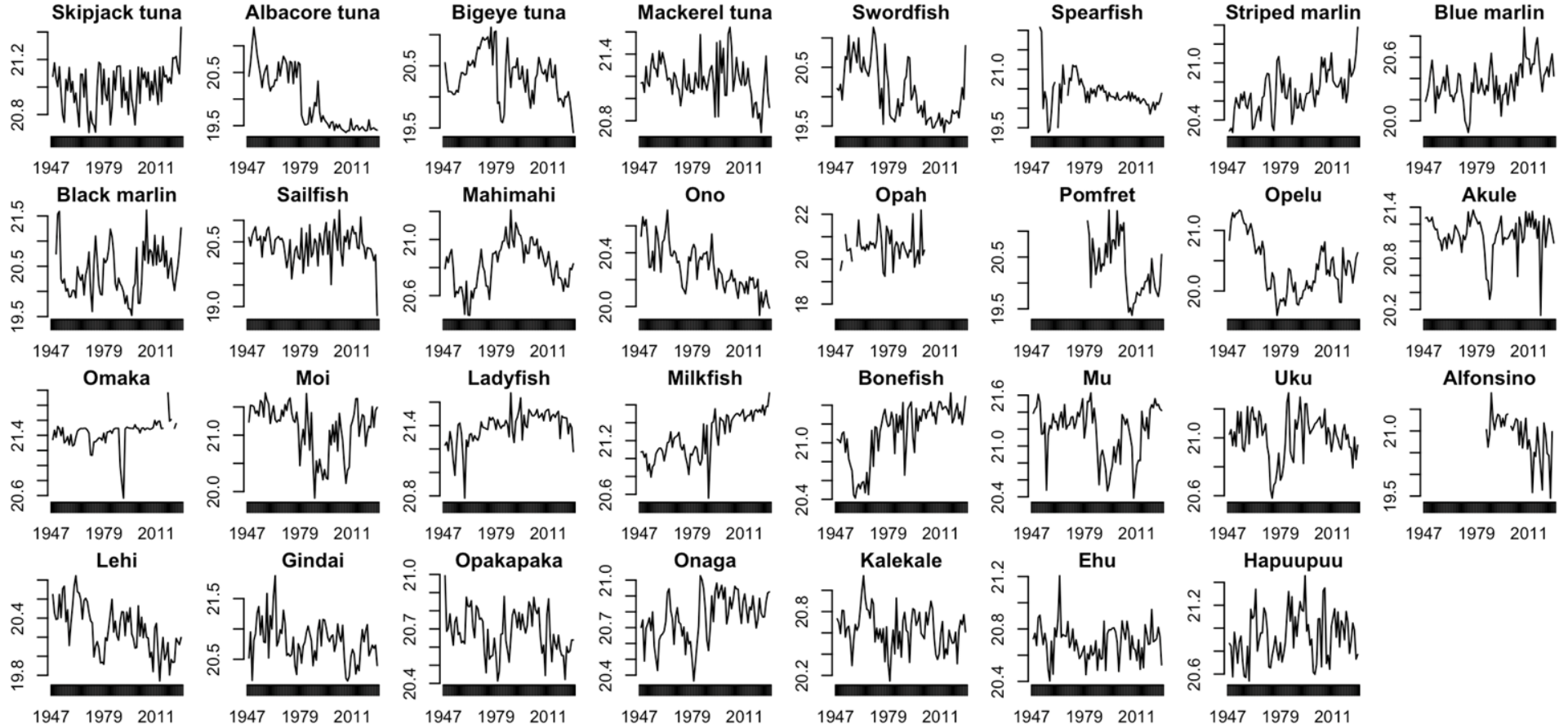




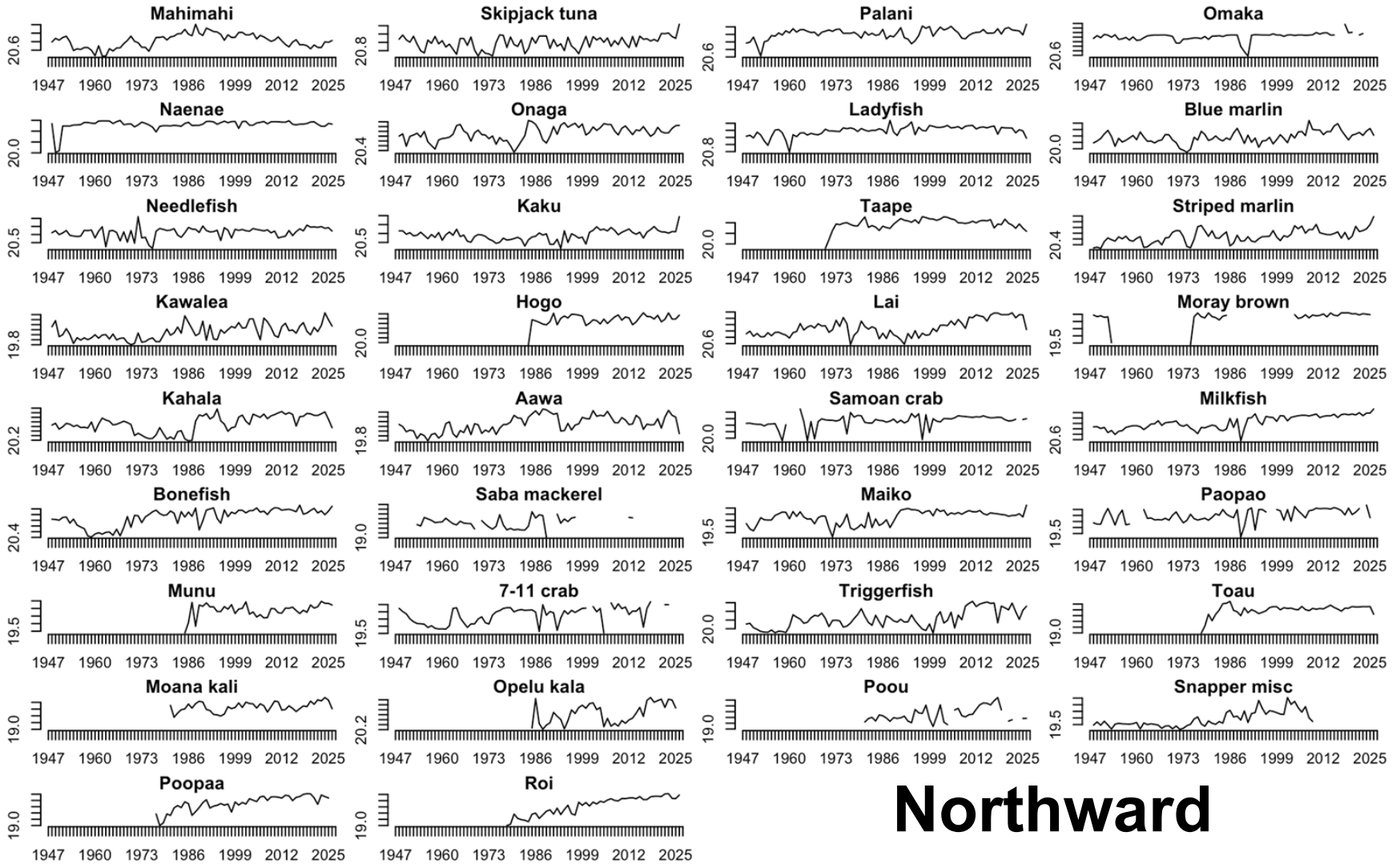
Partial time series

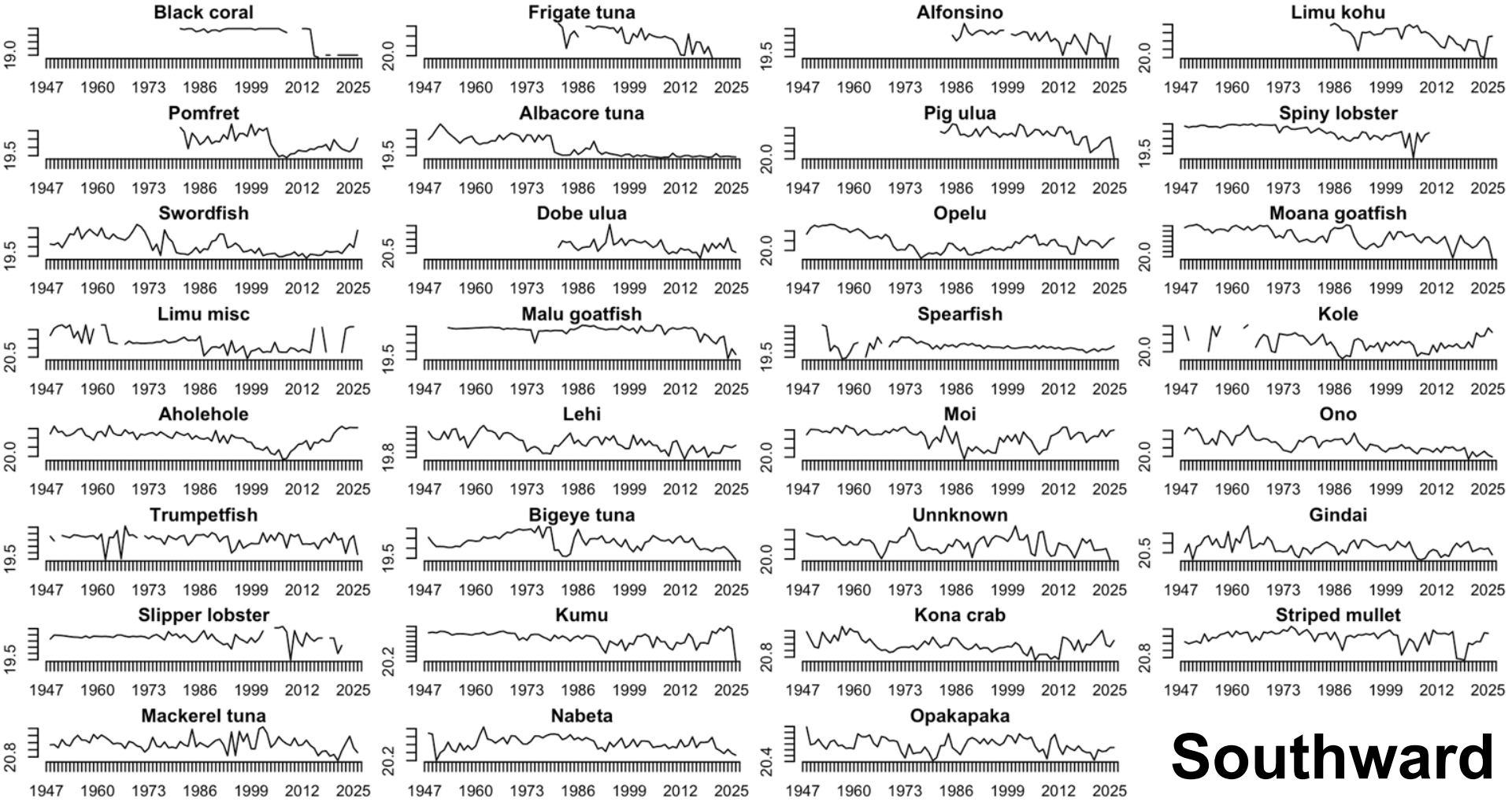


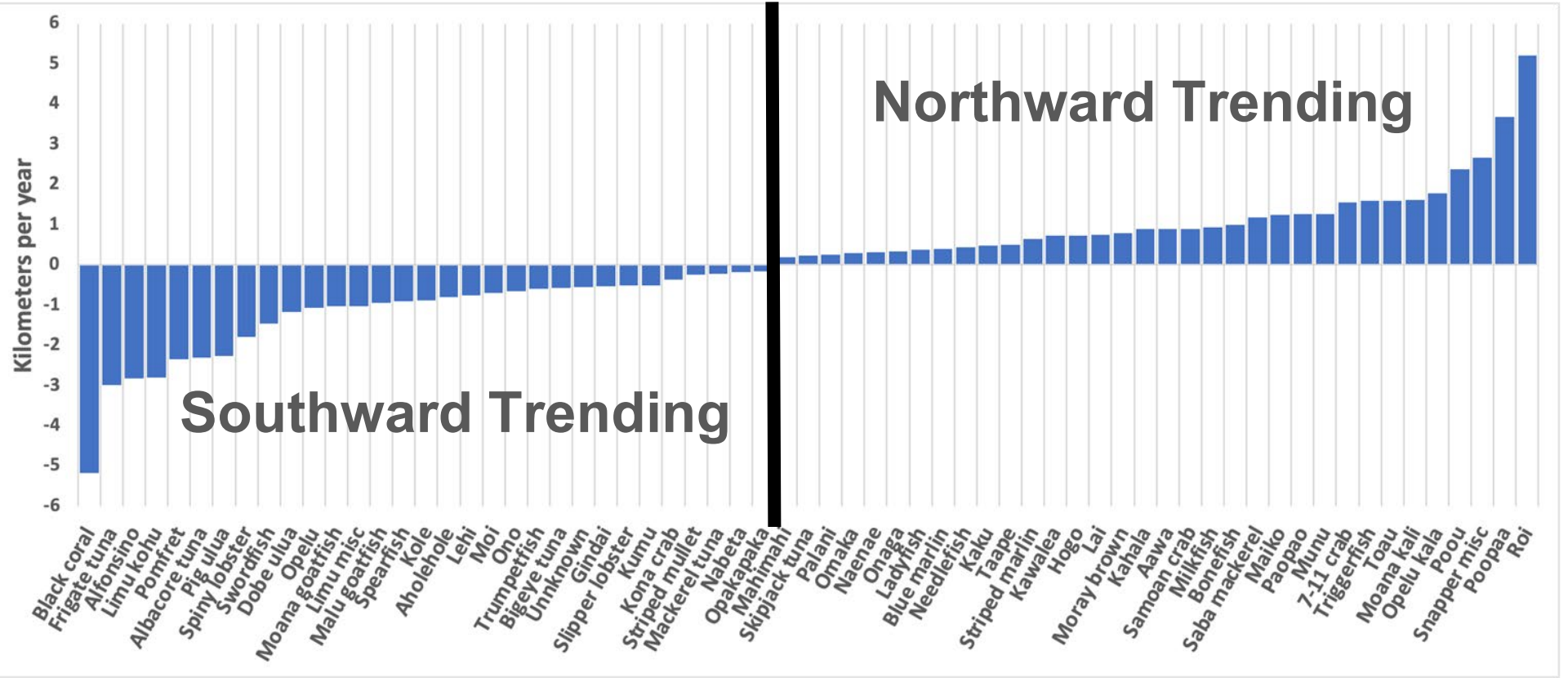
Various non-fish taxa



Commercial and recreational targets

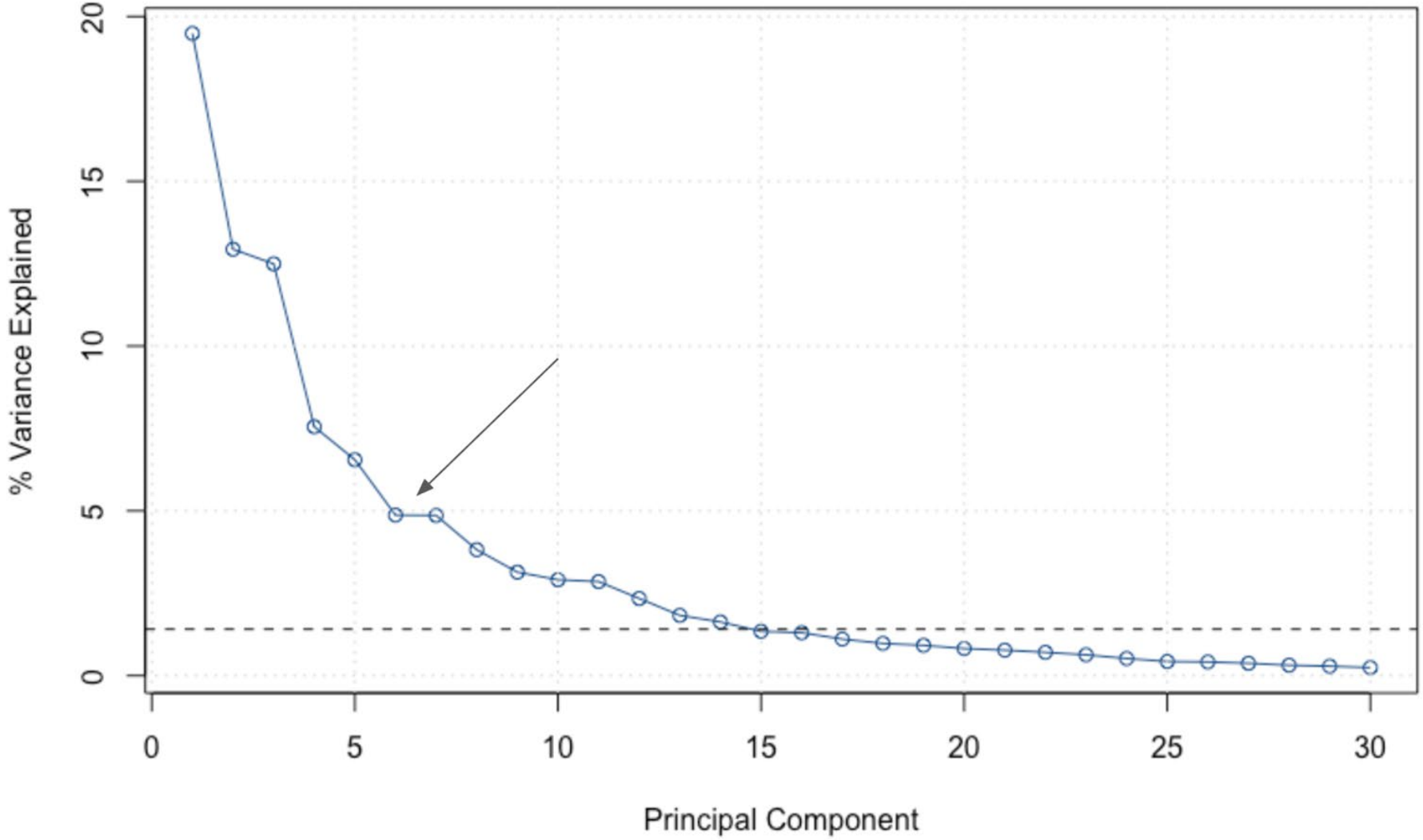

Mahimahi
Skipjack tuna
Palani
Omaka
Naenae
Onaga
Ladyfish
Blue marlin
Needlefish
Kaku
Taape
Striped marlin
Kawalea
Hogo
Lai
Moray brown
Kahala
Aawa
Samoan crab
Milkfish
Bonefish
Saba mackerel
Maiko
Paopao
Munu
7-11 crab
Triggerfish
Toau
Moana kali
Opelu kala
Poou
Snapper misc
Poopaa
Roi
1947 1960 1973 1986 1999 2012 2025
Northward

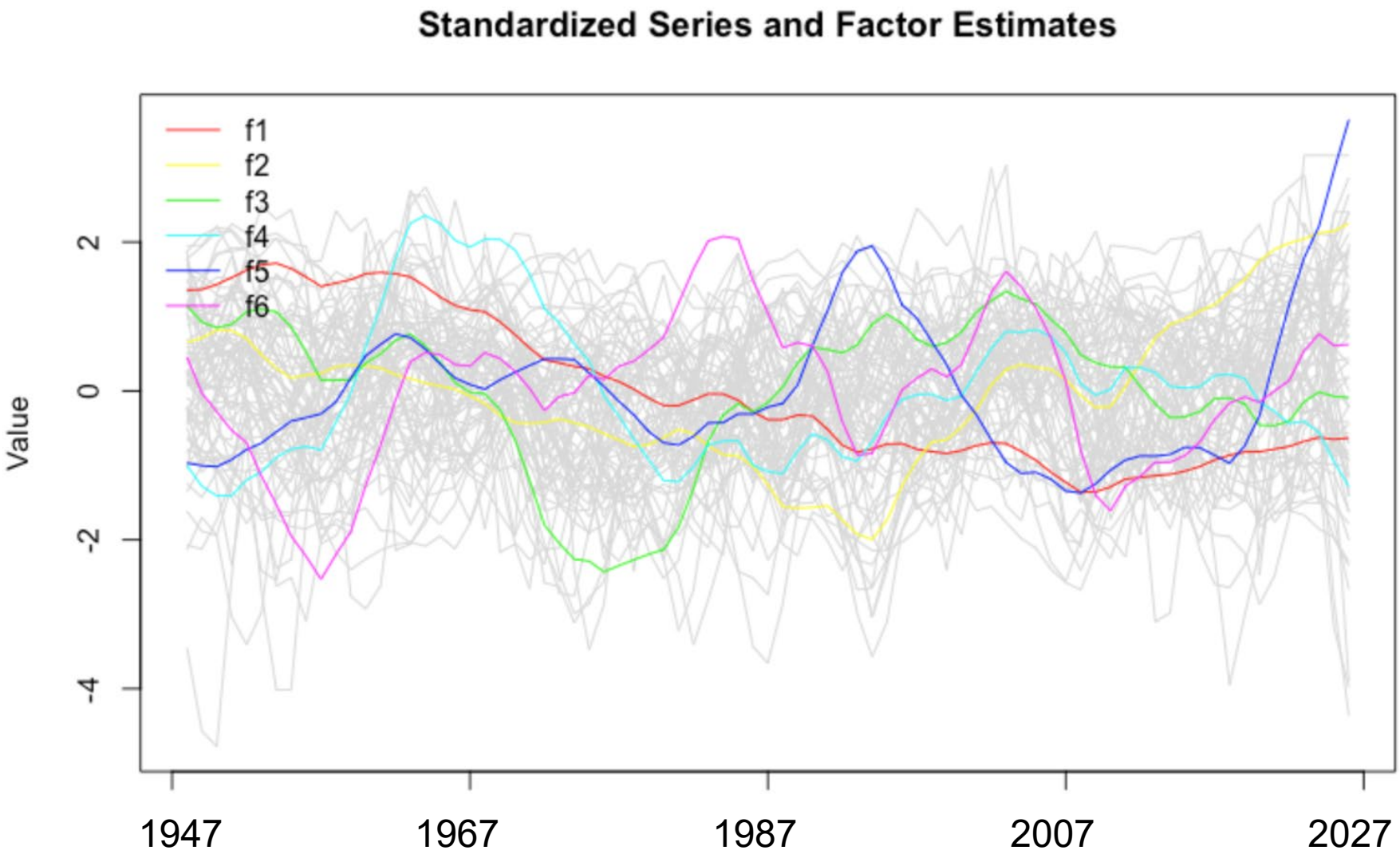

Black coral
Frigate tuna
Alfonsino
Limu kohu
Pomfret
Albacore tuna
Pig ulua
Spiny lobster
Swordfish
Dobe ulua
Opelu
Moana goatfish
Limu misc
Malu goatfish
Spearfish
Kole
Aholehole
Lehi
Moi
Ono
Trumpetfish
Bigeye tuna
Unnknown
Gindai
Slipper lobster
Kumu
Kona crab
Striped mullet
Mackerel tuna
Nabeta
Opakapaka
1947 1960 1973 1986 1999 2012 2025
Southward

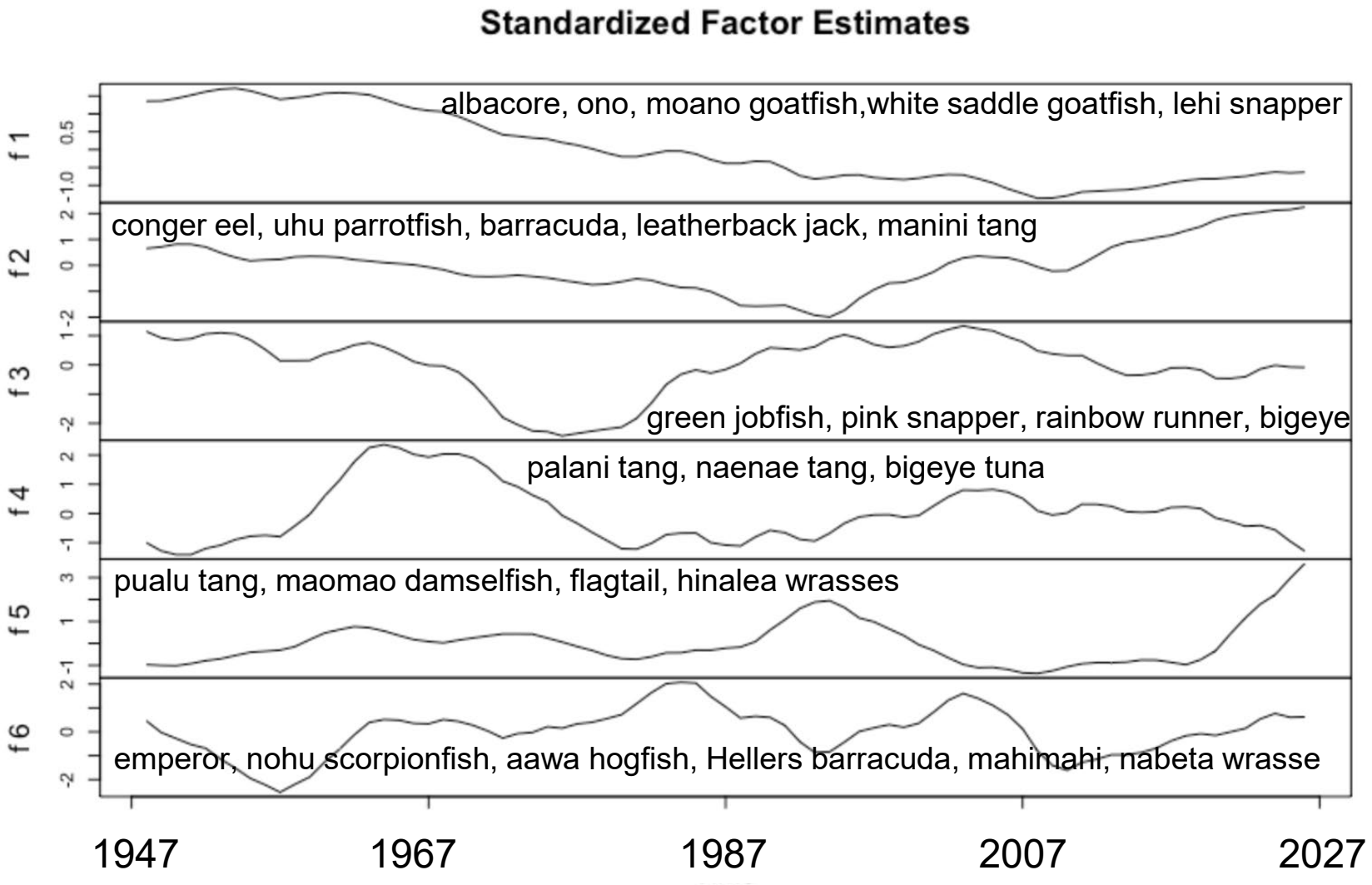

Kilometers per year
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
Southward Trending
Northward Trending
Black coral
Frigate tuna
Alfonsino
Limu kohu
Pomfret
Albacore tuna
Pig ulua
Spiny lobster
Swordfish
Dobe ulua
Opelu
Moana goatfish
Limu misc
Malu goatfish
Spearfish
Kole
Aholehole
Lehi
Moi
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Bigeye tuna
Unnknown
Gindai
Slipper lobster
Kumu
Kona crab
Striped mullet
Mackerel tuna
Nabeta
Opakapaka
Mahimahi
Skipjack tuna
Palani
Omaka
Naenae
Onaga
Ladyfish
Blue marlin
Needlefish
Kaku
Taape
Striped marlin
Kawalea
Hogo
Lai
Moray brown
Kahala
Aawa
Samoan crab
Milkfish
Bonefish
Saba mackerel
Maiko
Paopao
Munu
7-11 crab
Triggerfish
Toau
Moana kali
Opelu kala
Poou
Snapper misc
Poopaa
Roi

Dynamic Factor Analysis

- Perform dynamic factor analysis using the R package dfms (state space EM approach)
- Extract salient patterns, align species assemblages with patterns
- Subset of trajectories with complete 79 years (n=71)


% Variance Explained
0
5
10
15
20
0
5
10
15
20
25
30
Principal Component


Standardized Series and Factor Estimates
f1
f2
f3
f4
f5
f6
Value
2
0
-2
-4
1947
1967
1987
2007
2027


Standardized Factor Estimates
f 1
albacore, ono, moano goatfish,white saddle goatfish, lehi snapper
f 2
conger eel, uhu parrotfish, barracuda, leatherback jack, manini tang
f 3
green jobfish, pink snapper, rainbow runner, bigeye
f 4
palani tang, naenae tang, bigeye tuna
f 5
pualu tang, maomao damselfish, flagtail, hinalea wrasses
f 6
emperor, nohu scorpionfish, aawa hogfish, Hellers barracuda, mahimahi, nabeta wrasse
1947
1967
1987
2007
2027

Caveats & Responses

- **Data artifacts: species identification, potential for monthly aggregate reporting, standardization**
- **Fisher inputs: skill/behavior, targeting, gear effects, technology, trip length, marketing, environment**
- **What about longitude?**
- **What about non-commercial catch?**

Summary & Next Steps

- Compelling evidence of northward and southward movements of species in Hawaii
- Persistent nonlinear patterns as well
- Patterns can be tentatively assigned to groups
- Continue efforts to decouple movement from other influences
- Incorporate correction for multiple tests
- Explore longitudinal patterns
- Explore environmental covariates
- Questions? Email me at: Donald.Kobayashi@noaa.gov

